

FLYING FORTRESS

OPERATORS MANUAL

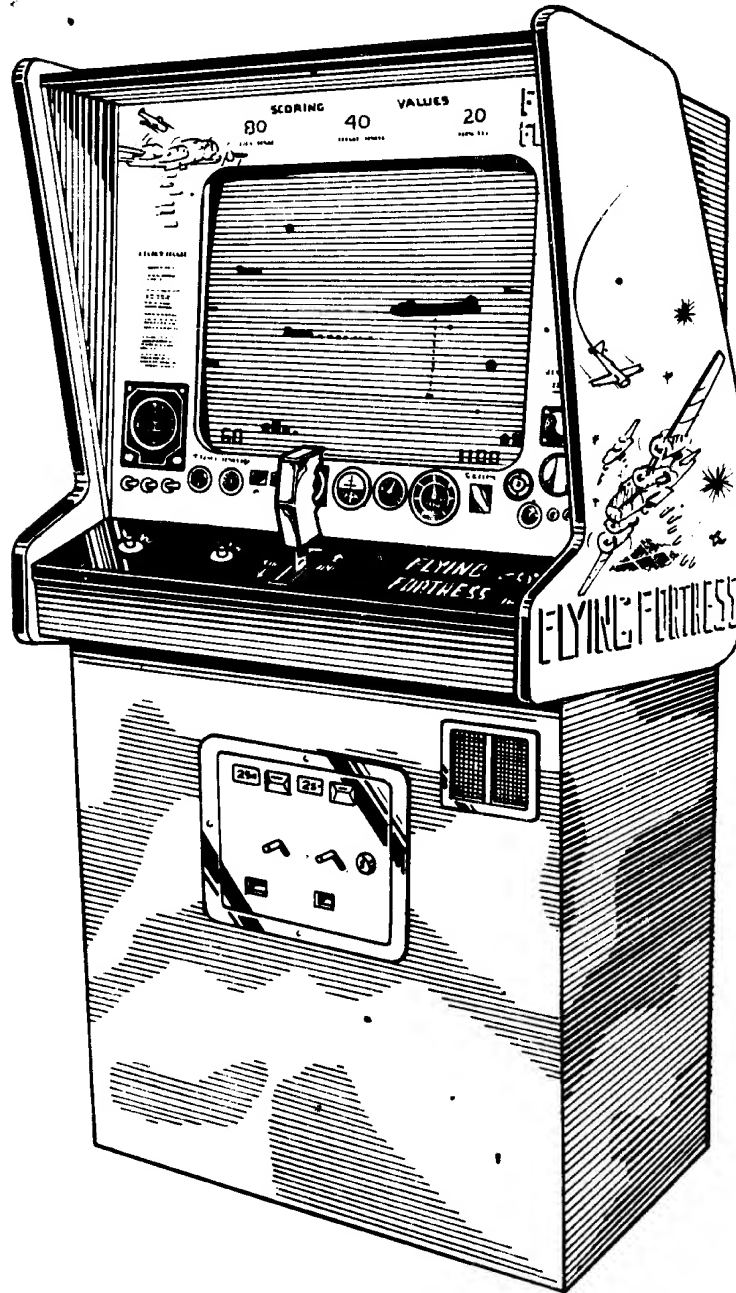


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MANUFACTURER'S WARRANTY

Except as hereinafter stated, Electra Games, Inc. warrants the video monitor and the modular electronic printed circuit boards used in this product to be free from defects in material or workmanship under normal use for a period of:

60 days from date of shipment - video monitor assembly

6 months from date of shipment - modular electronic printed circuit boards and parts thereon.

None of the other products or parts thereof are warranted.

Our obligation under this warranty is limited to repairing or replacing aforementioned products provided:

- 1) Electra Games, Inc. Service Department is promptly notified in writing by buyer that said products are defective.
- 2) Defective products are returned prepaid to Electra Games, Inc. Service Department.
- 3) Upon return of defective products, our examination shall disclose to our satisfaction that:
 - a) Any of said products have not been subject to misuse, neglect, accident, incorrect wiring not our own, improper installation or use in violation of instructions furnished by us;
 - b) Any of said products have not been repaired or altered by anyone other than us;
 - c) Manufacturers date code or the serial number of the products has not been removed, defaced or changed.

The Seller expressly excludes all implied warranties or merchantability and fitness for a particular purpose. Purchaser's remedies are expressly limited to its rights under this warranty. No representative or person is authorized to assume for us any other liability in connection with the sale of our product.

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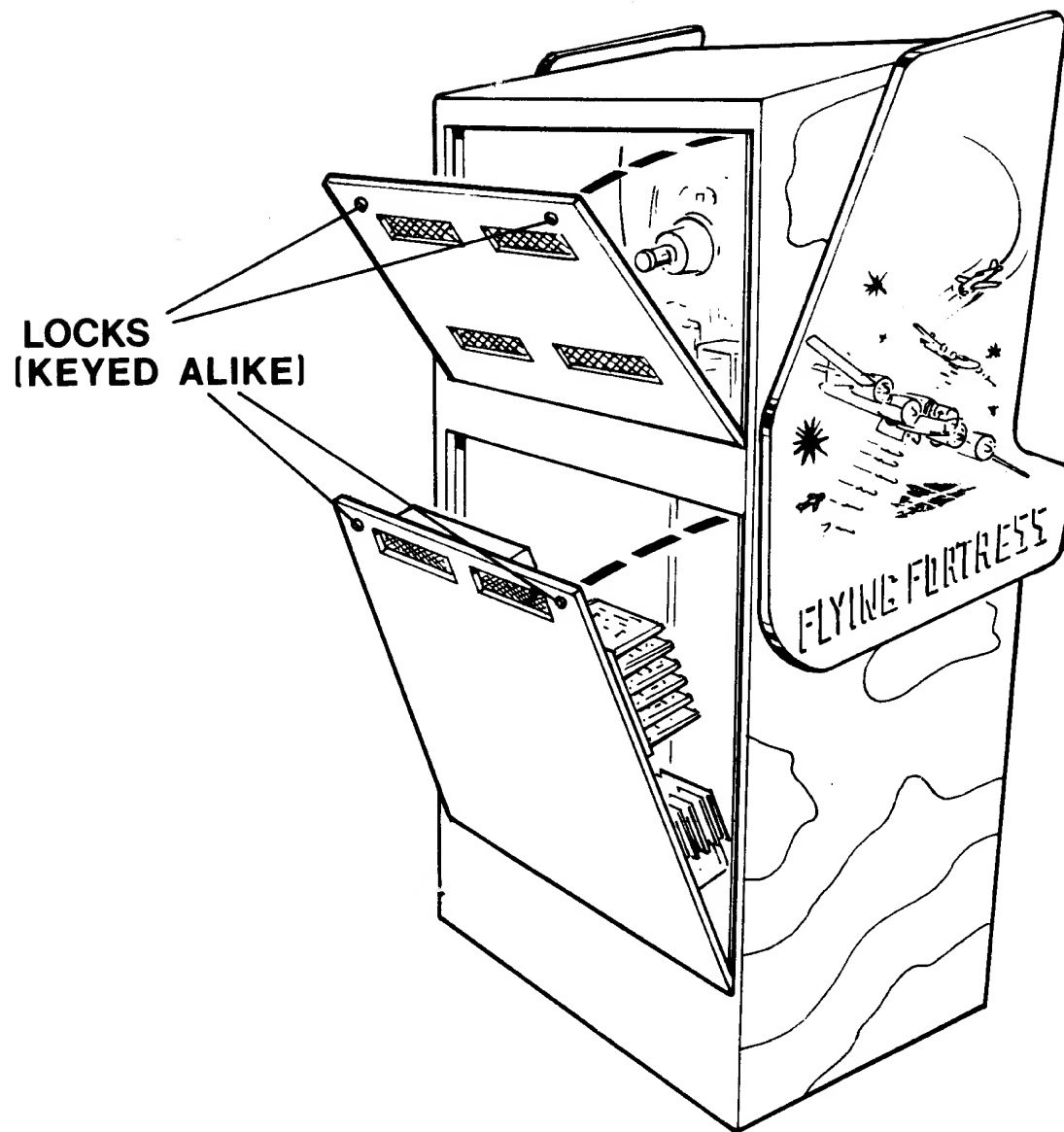
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INTRODUCTION

Flying Fortress is a completely solid state video game which utilizes state-of-the-art semiconductor components. The game display and logic sequence are generated by two printed circuit boards. A 23-inch Motorola video monitor displays the game picture, and a unique sound simulator adds realistic sounds to complete the environment. All game sub-assemblies are accessible through two removable doors on the back of the cabinet.

Flying Fortress is a game for one player who controls a World War II bomber. Points are scored by bombing structures passing on the ground below, or by shooting down attacking "bandit" fighters while successfully avoiding the bandits or anti-aircraft fire.

In this manual you will find a description of the game sequence of play and an explanation and location of all game adjustments. There are also sections detailing the logic of the game and providing troubleshooting assistance in case of problems.



**CABINET ACCESS
FIGURE 1**

CABINET ACCESS

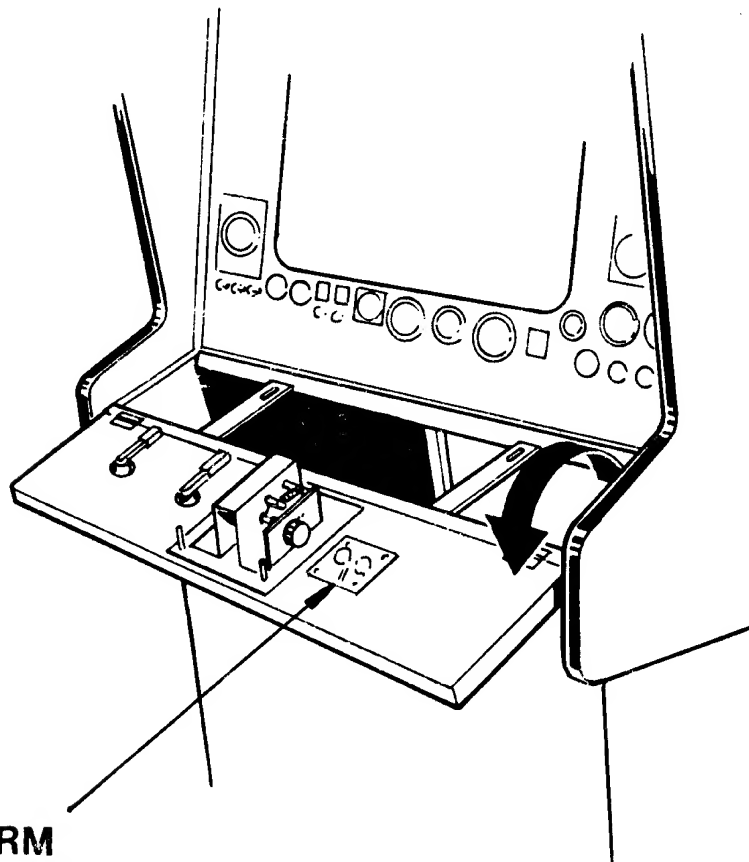
Sub-Assemblies

All sub-assemblies are accessible by opening two doors on the back of the cabinet. Removal of the upper door provides access to the Motorola monitor. Open the lower door to gain access to the EG1060A and EG1060B logic boards, power supply assembly and sound system. Refer to Figure 1. Note: Open the lower door carefully as several components are mounted on it.

Each door has a set of common locks which accept the same key. Keys for these locks are in the instruction manual envelope.

Control Panel

The control arm mechanism and push button switches are mounted on a hinged front panel. Two wing nuts secure the control panel to the cabinet frame. To service any part of the control panel, simply remove two wing nuts and swing the control panel open. Refer to Figure 2.



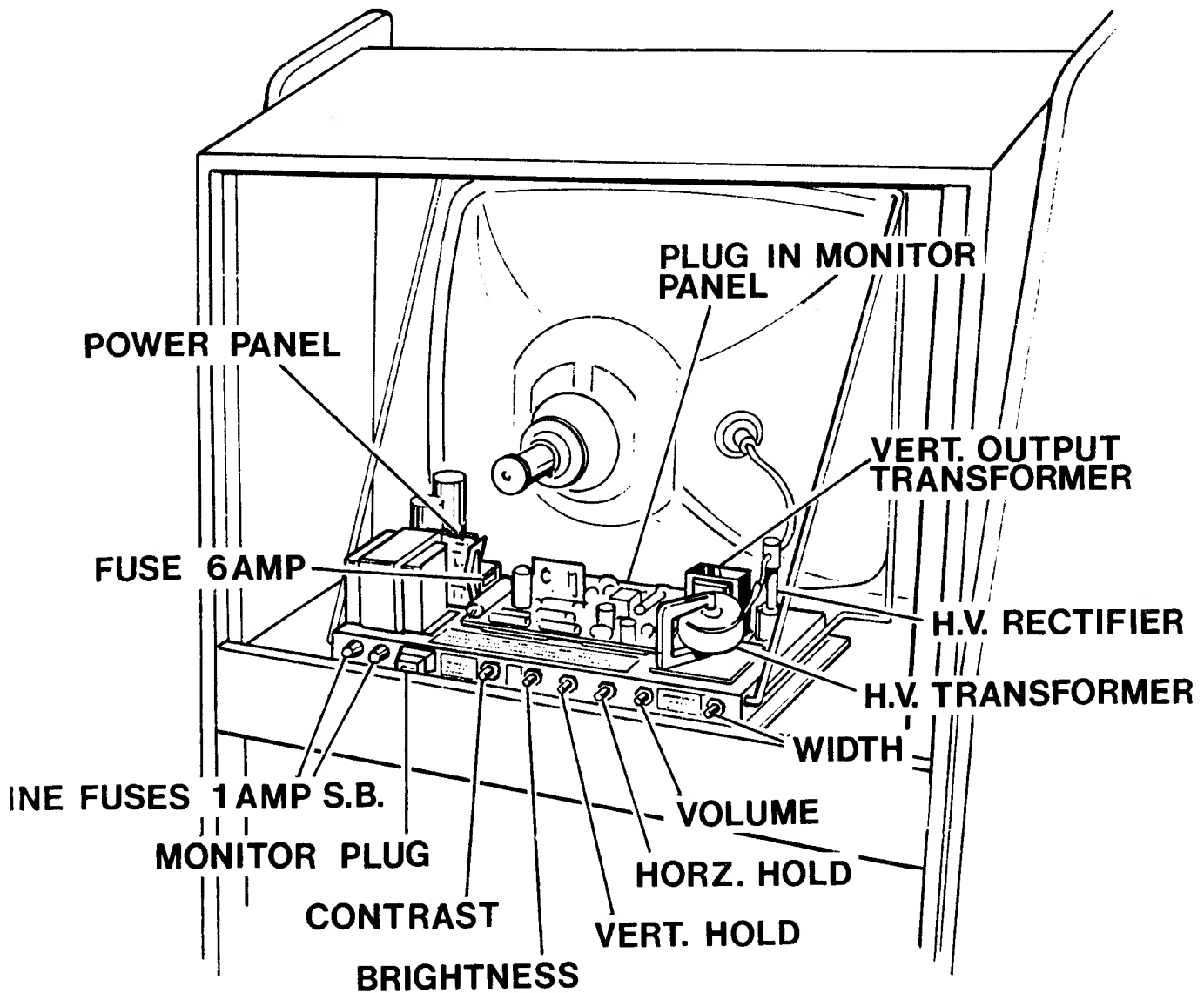
**CONTROL ARM
ADJUST BOARD**

**FRONT PANEL ACCESS
FIGURE 2**

INSPECTION

Make a preliminary inspection of the game before applying power. Open both cabinet doors and inspect for the following:

Refer to Figure 3: Inspect the video monitor for any obvious damage. Insure that two printed circuit boards are securely mounted on the chassis and the high voltage rectifier is in place and not damaged.

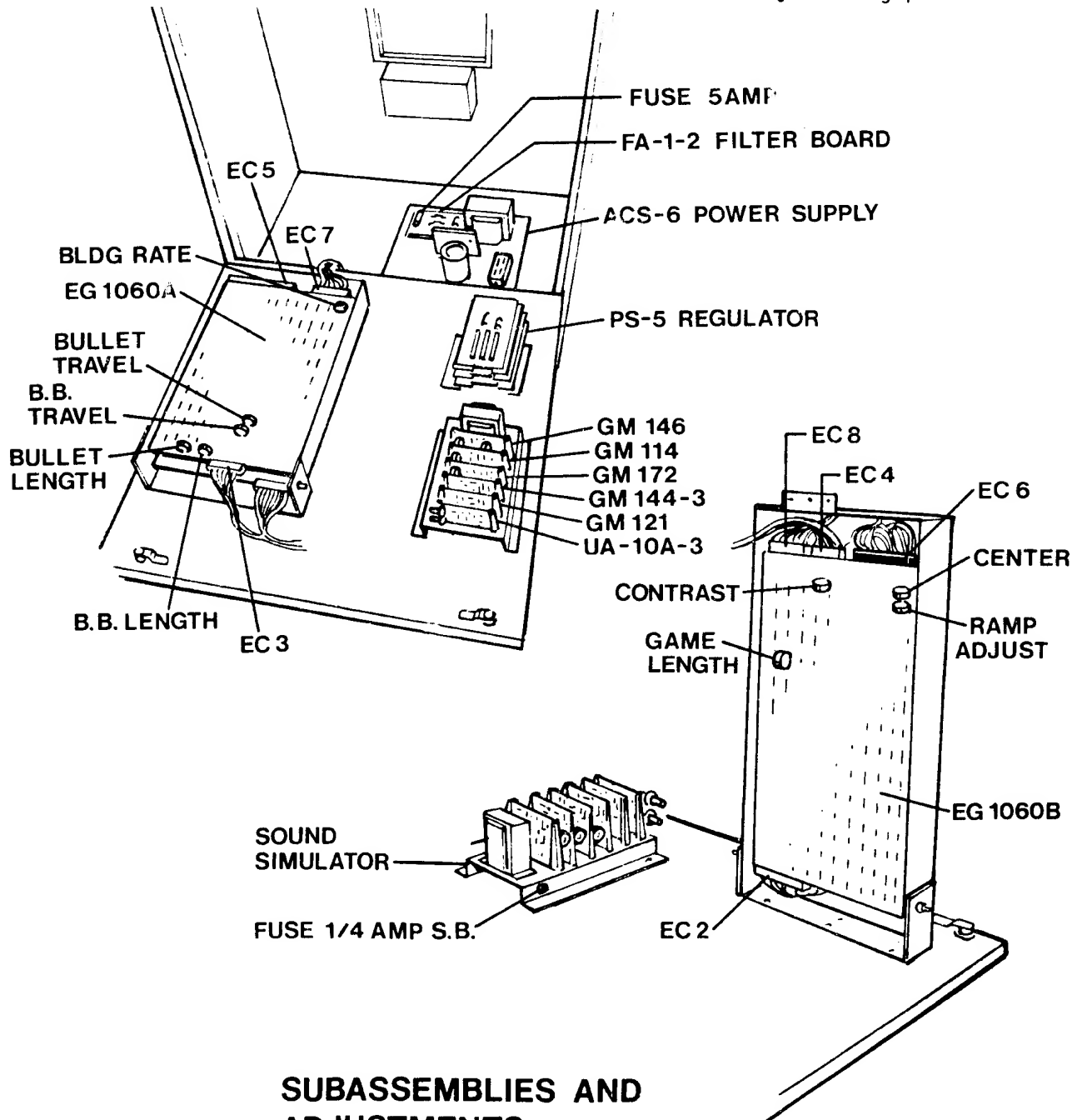


**MONITOR ASSEMBLY
FIGURE 3**

Refer to Figure 4: Insure that all printed circuit board assemblies are properly mounted and that edge connectors are in place and fully seated.

The sound simulator system should be secure and all printed circuit modules fully seated in their card guides.

Open the coin mechanism door and inspect both coin mechanisms for proper operation. Use a WD-40 silicone lubricant to lubricate any binding parts.



**SUBASSEMBLIES AND
ADJUSTMENTS
FIGURE 4**

DISASSEMBLY FROM SHIPPING PALLET

The cabinet is bolted on the shipping pallet with four 3/8 inch bolts. Remove the four bolts from inside the base of the cabinet.

SET UP

Install four adjustable legs (located in the cash box) into threaded "T" nuts on the bottom of the cabinet base.

Note: These legs must be installed so that the cabinet will be properly ventilated. If the game is to be operated on a carpeted floor, adjust legs to a height sufficient to allow air circulation into the vent holes in the bottom of the cabinet.

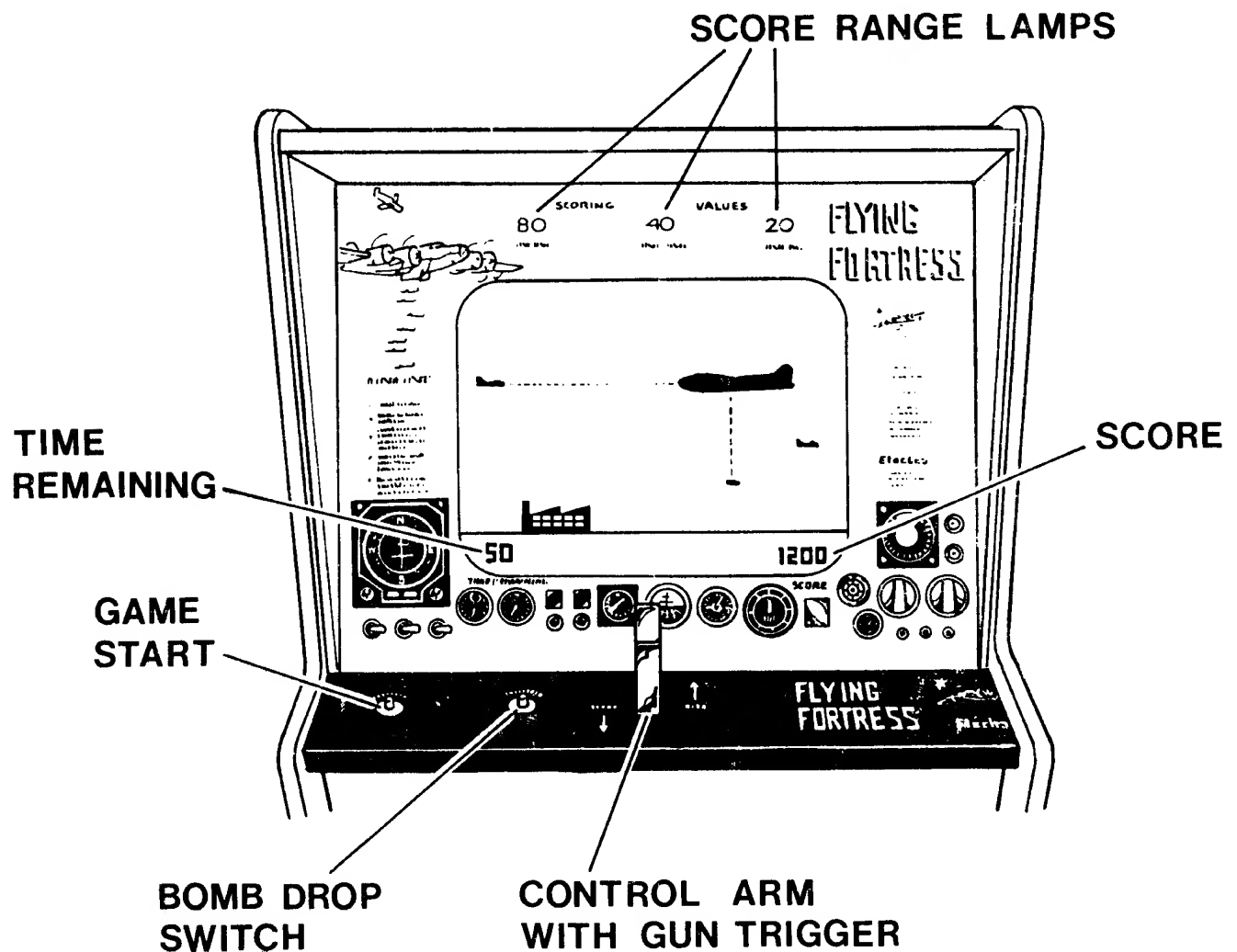
Locate the 120 VAC power cord inside the game and push the plug through the hole provided in the back of the cabinet. Plug the power cord into a convenient 120 VAC 60 HZ receptacle.

GAME OPERATION

Refer to Figure 5 for location of controls.

1. Power On - The game is powered up by setting the POWER toggle switch ON (located on the rear of the cabinet, lower left-hand corner). After an initial warm-up period the game display will appear on the screen.
 - a. Bandits will appear from the left and fly across to the right.
 - b. Buildings will pass from left to right along the ground.
 - c. Random bursts of antiaircraft fire will appear in the sky.
 - d. In the ground display, 2 digits will appear on the left, 4 digits on the right.
2. Credit - Credit is established by inserting one coin (see Game Logic section: Coin-up and Game Start for procedure to require 2 coins for credit). Score will reset to 0000.
3. Game Start - Press GAME START switch on the control panel to begin action.
 - a. The bomber will appear on the right edge of the screen and begin moving to the left.
 - b. Game sounds will be evident, including the multi-engine sound, machine gun sound and the "pop" of the ack-ack.
 - c. The 20 score lamp will be lit.
 - d. "Time Remaining" display will set to 90 and begin counting down.
4. Game Action - Moving the control stick forward will cause the bomber to dive; pulling it back will cause the bomber to climb. Pressing the trigger switch in the control arm will cause bullets to shoot from the nose of the bomber. Pressing the BOMB RELEASE button will cause a bomb to fall from below the bomber.
 - a. Use the control stick to avoid bandits, ack-ack and the buildings. A collision or being shot by a bandit or ack-ack fire will cause the bomber to momentarily flash, then disappear and reappear on the right edge of the screen.

- b. Bombing a structure on the ground or shooting down a bandit scores points. When the bomber is on the right side of the display targets are worth 20 points each. As the bomber progresses across the screen targets are worth 40 and then 80 points each. Thus, avoiding attacks by bandits and avoiding ack-ack allow higher scoring.
- c. If the score exceeds a preset limit when time runs out, time will reset to 30 for one extended play. After the additional time, or after the first interval with score below the extra play limit, the bomber will disappear and game sounds will cease. The score required for earning extra play can be set by putting jumper wires on the EG1060B logic board. Refer to Game Logic section.



**GAME CONTROLS
FIGURE 5**

ADJUSTMENTS

All units are factory adjusted and need not normally be readjusted. The following lists some adjustments should they be necessary.

- 1.0 Monitor - Refer to Figure 3 and Motorola Service Manual File VP12 for the location of controls.
 - 1.10 Contrast - Adjust the contrast control to its extreme clockwise limit.
 - 1.20 Brightness - Adjust the brightness control to its extreme counter clockwise limit.
 - 1.30 Vertical Hold - Adjust if the picture rolls vertically across the screen.
 - 1.40 Horizontal Hold - Adjust if the picture is warped or broken into diagonal lines.
 - 1.50 Volume - Set to minimum. The audio section of the monitor is not used.
 - 1.60 Width - Controls the horizontal dimension of the picture. Adjust if horizontal picture size changes.
 - 1.70 Vertical Size - Located on the Plug-In monitor panel P.C. board. Vertical size and vertical linearity are interdependent. The vertical size adjustment changes the vertical dimension of the picture.
 - 1.80 Vertical Linearity - Located on the Plug-In monitor panel P.C. board. Adjust if images appear to be compressed at the top or bottom of the picture.
- 2.0 Logic Boards - Refer to Figure 4 for the location of all logic board adjustments.
 - A. EG1060B
 1. Contrast - Adjust the video monitor contrast and brightness controls as described in the monitor adjustments section before adjusting EG1060B contrast control. Then adjust this control for a generally dark sky with bright simulations.
 2. Centering - Adjust to center picture horizontally on the screen.
 3. Game Length - Sets the timing interval for the game. Adjustment range is from about 60 to 150 seconds.
 4. Ramp Adjust - Sets vertical range of the bomber. This adjustment, in conjunction with the TRIM pots on the control arm adjust board assembly, controls bomber vertical position. The ramp should be adjusted so that the bomber can range from near ground level to near the top of the screen. The TRIM pots vary the voltage range and bias from the control arm, and thus interact with the ramp adjust control.

B. EG1060A

1. Building Rate - Controls the range of speeds at which buildings pass along the ground. Note: The bomber position also has an effect on the building rate. As the bomber flies lower the buildings pass more rapidly.
 2. BB Travel - Controls how far bomber bullets travel after being shot by the player.
 3. BB Length - Controls the length of the bullets which shoot from the bomber.
 4. Bullet Travel - Controls how far bandit bullets travel from the bandits.
 5. Bullet Length - Controls the length of the bullet stream shot by the bandits.
- 3.0 Control Arm Adjust Board Assembly - Refer to Figure 2 for location of this assembly. There are 2 Trim Pots on this board which adjust the voltage to the control arm pot. There is a Zener diode on this board to limit maximum voltage out of the control arm, so the absolute upper limit is predetermined. These controls interact with the Ramp Adjust control (EG1060B Logic Board) to determine the vertical limits of the bomber motion. The bomber should be very near the ground when stabilized after full dive command, and near the top of the screen after fully climbing.
- 4.0 Sound Simulator System - Refer to Figure 4 for location of individual boards. Each simulator module has an independent volume control. In addition, the GM114 Bomb Drop module has a rate control to set how fast the sound changes pitch. The UA-10A-3 amplifier has a master volume and a tone control. First adjust the individual volume controls to give the appropriate effect. Next adjust the master volume control for your location. Finally, the tone control, a treble cut control, should be adjusted for the most effective overall effect.

FUSES

- 1.0 Main Fuse - The main fuse for the game is located on the FA-1 board. See Figure 4. Game fuse (F1) is series connected with the 120 VAC line input. Replace only with a 5 amp Norm-Blo.
- 2.0 Sound Simulator System - A 1/4 amp Slo-Blo fuse is wired in series with the 120 VAC line input to the Sound Simulator System. The fuse is physically mounted on the metal chassis of the sound system. See Figure 4.
- 3.0 Video Monitor - Refer to Figure 3. Two 1 amp Slo-Blo 120 VAC line fuses (F1 & F2) are wired in the primary winding of the power transformer and are the main monitor fuses. Replace only with same or equivalent rated fuse. A 6 amp Fast-Blo fuse (F3) is connected in the secondary winding of +5 VDC power supply section.

FLYING FORTRESS MAJOR SECTIONS

1.0 Video Monitor

Refer to EG1060 Wiring Diagram and Motorola Service Manual File VP12.

Flying Fortress uses a 23-inch solid state Motorola monitor (XM701-10) to display the game picture. All interface between the game logic and monitor is through the monitor plug mounted on the rear of the monitor chassis. Composite video input (pin 1) and video ground (pin 2) are routed from the EG1060B logic board. The audio section of the monitor is not used.

A 5 volt DC, 3 amp power supply is included in the monitor for powering external systems. This voltage, available on pin 6 of the monitor plug, powers the score lamps in this game.

Generally speaking, the approach to servicing the video monitor should be the same for most commercial televisions. Identify and associate the problem with a major section, then troubleshoot and eliminate the possibilities until the problem is identified. If servicing is required, it may be necessary to pull the monitor from the cabinet. This is accomplished simply by removing four screws which secure the chassis to the cabinet.

General problems and area of suspicion are as follows:
Refer to Motorola Monitor Schematic.

- 1.1 Problem - No power (monitor dead)
Section - Low voltage power supply.
- 1.2 Problem - No raster (power but screen is dark)
Section - High voltage, horizontal output, horizontal oscillator.
- 1.3 Problem - No video
Section - 1st, 2nd video amplifier stages, video output.
- 1.4 Problem - No horizontal sweep
Section - Phase detector, horz. oscillator, horz. pulse shaper, horz. driver, horz. output, horz. yoke windings.
- 1.5 Problem - No vertical sweep
Section - Vertical oscillator, vert. driver, vert. output, vert. yoke windings.
- 1.6 Problem - No vertical sync
Section - Sync separator, vertical oscillator.
- 1.7 Problem - No horizontal sync
Section - Horizontal oscillator.

2.0 Power Supply, ACS-6

Refer to Figures 4 and 6.

The ACS-6 Power Supply consists of the FA-1-2 Filter Board, the power transformer, the rectifier diodes, the convenience outlet, and a filter capacitor. The unit supplies filtered +12VDC for the PS-5 regulator, and 120VAC for the sound simulator, monitor, and 120VAC lamps.

The 120 VAC line power is cleaned up by the FA-1-2 board, which also contains the 5A Norm-Blo fuse. The board output is routed to the convenience outlet and to the primary of the power transformer. For 120VAC operation, the two primary windings are wired in parallel; for 240VAC service the primaries are wired in series, with the convenience outlet wired across one winding. The transformer secondary provides 19VAC, center tapped. The 1N3209 diodes provide full-wave rectification of this voltage, and the resultant DC is filtered by the 32,000 uf capacitor and fed to the PS-5 regulator.

3.0 PS-5 Regulator

Refer to Figures 4 and 7.

This regulator consists of the P.C. board and three 2N3055 transistors mounted on the heat sink.

The +12VDC input is regulated to +5V by the 7805 regulator at currents up to 1A. At currents above 1A, the D45C8 transistor turns on the three 2N3055 transistors to provide up to 10A current maximum output.

4.0 Logic Boards EG1060A and EG1060B

Refer to Figure 4 and A1-3 and B1-3 schematics.

The game logic is contained on these boards. The EG1060A board generates timing signals, position signals, bullet and bomb video, and ground and score video. The EG1060B logic board simulates the ACK-ACK and explosions, provides memories and circuits to generate plane (bandit and bomber) and building video, controls audio simulations, and generates score and time signals. Refer to Game Logic section in this manual for a detailed discussion of the operation of these circuits.

5.0 Sound Simulator System

Refer to Figures 4 and S1-6, sound system schematics.

The modular sound system provides multi-engine plane sounds, machine gun sound, anti-aircraft explosion, falling bomb sound and explosion sound. The system consists of the Mother Board and chassis, an audio amplifier module (UA-10A-3) and 5 plug-in P.C. sound modules.

- A. Mother Board and Chassis - The mother board provides all interface connections between the amplifier and sound modules. An 18-pin edge connector on the mother board provides interface between the simulator and the logic board (EG1060B) for sound control, and sound output to the speaker. The transformer on the chassis provides 33VAC, 19VAC and 12VAC to the audio amplifier.
- B. Audio Amplifier UA-10A-3 - All simulated sounds are amplified by this 8 watt amplifier board. Also, the 12VAC and 33VAC supplied to this board are converted into +15VDC and +17VDC, respectively.

The +15VDC (from diodes D 3-6 and filter capacitor C8) powers the two audio amps, IC1 and IC2. The +17VDC provides B+ to the sound modules.

C. Sound Modules - Provide realistic sounds during game play.

- GM 121 machine gun sound
- GM 144-3 explosion sound
- GM 172 ack-ack sound
- GM 114 bomb drop sound
- GM 146 multi-engine plane sound

Refer to Game Logic section of this manual for generation of sound control logic. Audio Disable signal turns on Q20 of UA-10A-3 board, grounding sound output. Individual modules receive B+ from a switch on the EG1060B logic board. Their outputs are fed to the UA-10A-3 and amplified. Refer to adjustments section for volume and tone controls discussion.

6.0 Control Panel

Consists of the Single Axis Control Arm Assembly, Control Arm Adjust Board Assembly, and Game Start and Bomb Drop Switches. Refer to Figure 2.

- A. Control Arm - Should require no adjustment. The Gun Trigger switch is removable by loosening the set screw in the grip beside the switch. The output pot can be oriented in any of several positions to provide best control linearity by removing the pot and rotating it to index in any of the smaller holes bored around its mounting hole. This is a 110° rotation 100KΩ linear taper pot.
- B. Control Arm Adjust Board Assembly - The two trim pots on this board adjust the range and bias of the control arm pot. Refer to Adjustments section for a discussion of how to adjust these pots. The two trim pots and the control arm pot form a voltage divider whose output is the control arm pot wiper. The 1K ohm resistor from the wiper acts as a current limiter and load for the Zener diode. The diode limits the output from the control arm to the logic board to 5.6VDC maximum.
- C. Bomb Drop and Game Start Switches - These two leaf switches are wired directly into game logic. They are adjusted and cleaned like any similar leaf switch.

7.0 Wiring Harnesses

Consist of the several cables and connectors that provide interface between logic boards, sound simulator, video monitor, PS-5 regulator, and control panel, lamps and the speaker.

GAME LOGIC

Introduction

The game logic is contained on the EG1060A and EG1060B printed circuit boards, mounted on the door of the lower cabinet (See Fig. 4). Figures A1-3 and B1-3 are schematic diagrams of the logic. To facilitate identification of integrated circuits, a grid system of letters and numbers is marked on each board. For clarity, a gate located on a circuit in position F7 on the EG1060A board will be referred to as F7A. The grid system identification is marked on the circuit elements on the schematics. Transistors and some logic elements are identified by abbreviated numbers on the diagrams. 16 and 55 by transistors refer to 2N3416 and 2N5355 respectively. 7400-series logic identification has been abbreviated by deletion of the 74, e.g., "85" refers to a 7485 comparator. Multiple gate IC's (7400, 7404, etc.) are shown only as discreet gates of a given chip, with proper pin numbers noted.

Troubleshooting the logic should present no significant problems assuming the serviceman has a working knowledge of common digital circuitry.

Coin-up and Game Start

These circuits are on Figure B3. Coining up the game will set the 2 D-Latches of H11B, causing CRED=1 to go high. Strapping pins 2 to 9 on H11B will require 2 coins to set CRED=1 high. Timer J10B prevents the game from coining up if it's banded.

Pressing START switch clocks the D-Latch I11B causing GS=1 to go high. The CRED=1 latches are reset at GAMOV low (game over - see section on scoring and timing) or PWRUP low. PWRUP goes low for a set time when power is applied or when a significant static charge approaches the game. This is detected by the static antenna to trigger timer D2A (Figure A1). This circuit prevents a player from initiating a game start with a static charge.

Master Timing

The 15.728 MHZ crystal and two inverters (G10A, Fig. A1) form the master oscillator for the game. This signal, divided by 2 in latch H10A is CNTCLK, the master clock. Subsequent counters I10 and J10A and latch H10A further divide this forming the horizontal division signals (1H - 256H). NAND F9A produces HSYNC, the game horizontal sync; NOR G9A produces MOVHS, the movable horizontal sync for the monitor. HSYNC is divided by counters A10 and B10A to produce the vertical division signals (V - 128V) and VSYNC, the game vertical sync. NAND B11A produces VIDVS, the vertical sync for the monitor. Counter I13 and latch I11A (Fig. A3) further divide VSYNC for VS/2 - VS/32. These horizontal and vertical signals will be used for all simulations in the game.

Video Simulation

Most simulations are created in a similar manner. 1H produces pulses at 256 per line. HSYNC produces pulses at 256 per vertical scan. By an array of counters and comparators an output pulse can be generated that occurs at any point of a 256 X 256 matrix defined by the vertical and horizontal signals. This point is then used to trigger the reading of a memory word to define dark and light areas of the simulation. Additional counters keep reading new words until the first line of the object has been read out, at which time reading ceases until the next line. This process continues until the entire object simulation has been read.

By counting the original counter arrays up or down, the starting point of an object can be moved on the screen, thus moving the entire simulation. To demonstrate this, the bomber simulation will be discussed in detail.

Bomber Simulation

The bomber horizontal location initially is on the right edge of the screen moving left. Leftward motion continues to the left edge unless something hits the bomber, at which time it starts over on the right. Rate of motion slows in 2 steps as the plane enters the higher scoring zones. Vertical motion is controlled by the player with the control stick. During the game the player can shoot the bomber gun, thus causing bullets to shoot from the aircraft nose, and he can release the bomb causing a falling bomb to appear under the bomber.

The horizontal position of the bomber is set by counters I6A and I8A (Fig. A2) and comparators I5A and I7A. The counters are preset by PLNLD generated on Fig. B3 whenever the plane is to be on the right edge of the screen. Motion to the left comes from the pulses picked out of multiplexer I12A (VS/8 in 20 point range, VS/16 in 40 point range, VS/32 in 80 point range). STOP is generated at the left edge of the screen to halt further motion. Output of this array is HPLNPOS, horizontal plane position, which clocks D-Latch I11A once per line.

Vertical position is determined by comparing the charge on a capacitor on the (-) input of op amp B12B (Fig. B1) with a ramp occurring at the VSYNC rate from timer J12B. The capacitor charge follows the control arm voltage, the range of which can be adjusted by the 2 pots marked TRIM. When the ramp voltage equals capacitor voltage the op amp gives an output to clock latch F12B. This will cause VB to go high whenever the other half of F12B gives it a high. This occurs initially when CRED=1 is high and GSCLK goes high. If the bomber is hit FLISH goes high and the latch is clocked at VS/2 rate, causing VB to flash. PLNBLNK high will reset the latch. The VB signal will normally remain high during the vertical space occupied by the bomber, and is clocked through latch I11A by HPLNPOS. PLN, the output, is a pulse at the starting point for the bomber. PLN enables shift registers H3 and J3B and counter J4B (Fig. B1).

It also allows CNTCLK to pass through AND H4B to clock the shift registers which serially decode the word which is being read in parallel from PROM I1B to AND-NOR arrays H2 and I3B. The decoded words are PLNVID, the bomber video. Each 8 bits clocked through the shift registers clocks counters J1 and 2B and J4B. The first 2 counters increment the PROM address, the last counts 8 words and then CLRA goes low to clear latch I11A, removing PLN. VSYNC resets address counters so each frame starts from the proper address. BLOC (bomb location) and BBPOS (bomber bullet position) are developed from the address counters to be used in bomb and bullet simulations.

Bomber Bullets

Pressing the gun trigger (Fig. A1) initiates the bomber bullets. The debounced trigger pulse clocks latch F3A, allowing BBCLK to go low when BBPOS appears. One-shot F2A then sets BBEN (bomber bullet enable) high for the period of time the bullets will be visible. This is adjustable by pot "BB TRAVEL" (See Fig. 4) to set how far the bullets travel across the screen. BBCLK loads the horizontal and vertical counters (J2, 4A, C2, 4A) with the proper address. The vertical counters are not further clocked since no vertical motion is synthesized. Horizontal counters are clocked by 64V coming through NAND G1A. BBNOW is the horizontal output, which clocks one-shot F3A. The output stays high for a period of time equal to bullet length (adjustable by pot "BB LENGTH", see Fig. 4). Combining the one-shot output with vertical array output is BB, which is chopped up by 2H to look like bullets.

Bomb Simulation

Activating the bomb drop switch (Fig. B2) clocks latch C7B, setting BOUT low. This signal on NAND G4B (Fig. B3) prevents BLOC from passing through to form SNCH. Prior to this, SNCH has been constantly updating counters A2A and A4A (vertical) and H2A and H4A (horizontal) with the bomber's position. These counters and associated comparators (A1&3A, H1&3A) give VBH (counted at VSYNC rate) and HBH pulses for vertical and horizontal bomb position, which clock latch D4A and G3A, respectively. The vertical signal clocks BOUT through for VBSLOT. Counter E4A resets this latch after 4 lines. VBSLOT is clocked through latch G3A and HBH to give HBSLOT, which is reset after 5 pulses by G2A. BL1, BL2 (E4A), BH1, BH2 and BH4 (G2A) are decoded by the seven gate array drawn between the counter/comparator arrays to give BOMB, the video for the bomb.

Bandit Simulation

Bandits appear at a random altitude on the left edge of the screen and cross to the right with a cyclic climb/dive pattern, while firing bullets in a random pattern. There are 2 bandits, one 128 horizontal bits behind the other.

Bandit 1 vertical position comes from C5-8A, Fig. A2. Initial position is preloaded by counter D8A, which is preloaded by NOW, a random signal from timer B13A. Latch E6A gives UP and DWN, which control how the vertical counter counts, thus how the bandit moves. Horizontal position 1HORZ comes from J5-8A, Fig. A2, which moves the bandit across the screen at VS/2 rate. VLD1 signal on this array determines when to preload the vertical counters. The 1HORZ and vertical signal are mixed in NOR D5A, giving BND1, the video.

Bandit 2 vertical comes from B5-8A, horizontal from latch D7A, which is clocked 128 1H pulses behind 1HORZ. Video comes out of NOR F11A as BND2.

BND1 and BND2 are multiplexed by F1B, Fig. B2, to access PROM D1B. Output is serially decoded to give BNDVID. BULLOC (bullet location) is also decoded and goes low at a random time set when the proper address coincides with timer J6B output.

Bandit Bullets

Simulation occurs on Fig. A1. BULLOC fires one-shot F2A ("BULLET DISTANCE" sets travel) to give BULEN. Vertical position comes from B1-4A, horizontal from I1-4A. Horizontal position feeds latch G3A, which is reset by the one-shot on its Q lead. "BULLET LENGTH" pot adjusts this time delay. The resulting video is BULLETS.

Building Simulation

Buildings appear on the lower left edge of the screen and move rapidly to the right. Several different buildings are simulated, any of which disappear when hit by a bomb.

Two simulators generate the buildings. Horizontal position for Building 2 comes from H5-8A, Fig. A2. The speed of travel is set by BLDCLK, which is generated on Fig. A3 by two 3900 op amps (A13A) in a voltage-controlled oscillator configuration. The BLDG RATE pot allows adjustment of the oscillator. Control comes from INLEV, derived from the bomber vertical position op amp B12B, Fig. B1. Horizontal output is BOBHER, which clocks 2 latches (F7A). The lower of the 2 sets AOBHER 96 pulses later.

VPTA (from NAND B11A) clocks latch B12A to give VSLT1, a vertical point. AND gate E10A clocks another latch, also B12A, to give VSLT2. These 2 points are vertical starting points for buildings. BLDOUT (from NOR G9A, NAND F9A) clocks latches C12A at BOBHER or AOBHER. XYZ (from A2&4A, Fig. A1) is clocked through C12A latches to select the building height. This is clocked through the appropriate latches to give BLD1 and BLD2. The timer on latch F10A keeps the appearance of one building from being predictable in higher scoring situations. BLD1 and BLD2 are combined in OR E11A to give BLD. Decoding of buildings is on Fig. B2. D2 and D4 (tens-digit bits from score) randomize the starting address. PROM A1B and B2B outputs are multiplexed for serial output by B1B and C2B. Combined outputs are BLDVID, building video.

Explosion and Ack-Ack Simulation

These are checkerboard patterns generated on Fig. B3 in similar fashion, except the explosion is four times as large as ack-ack (antiaircraft bursts). Position for explosions is set by VBH and HBH to correspond with the bomb.

EXEN sets the time for the explosion, which coincides with the bomb hitting a building, the ground, or a bandit, or being shot by bandit bullets.

Ack-ack position is set by VPOS and HPOS, generated by gates A5-8 and G5-8, Fig. A2. Time for generation is NOW, generated by timer B13A, Fig. A2.

Two pairs of counters accept the vertical and horizontal inputs and pulse the several gates located between. The decoded output is passed as video by one-shot F8B (explosion) or timer F7B (ack-ack).

Ground, Score and Timing Simulation

GRNDCLK is generated to clock latch D4A, Fig. A3. Output, GRND, blanked by SCORE forms GRNDVID, the ground video.

SCORE is blanking pulses for the seven-segment digits of time and the score. Time for the game is set by timer J9B, Fig. B2. GAME TIME pot allows adjustment of the game time. The timer output pulses count down counters H8-9B, which are preloaded to 90 at game start. The output (in BCD form) feeds multiplexers G6-9B, and is also decoded to detect zero time (ZCLK), which clocks latch J8B. This latch sets GAMOV (game over) high unless the player has exceeded the extended play score set in I7B. If he has exceeded the score required (which can be set according to the chart on Fig. B2), latch I7B (left latch) holds GAMOV low and causes EXTPLYCLK to go high. This reloads counters H8-9B to 30 and resets the extra play latch. When ZCLK again goes high GAMOV will also go high.

Score is also generated on Fig. B2. A bombed building or shot-down bandit causes HIT to go high, which clocks latch H5B, causing counters I6B and H7B to begin counting HSYNC. Latches C6B (2 each) and C7B monitor bomber horizontal position to set 20EN, 40EN or 80EN high and turn on proper lamps. One of these signals will set multiplexer E6B, which will cause latch H5B to reset after 2, 4 or 8 pulses. F6B outputs are D1, 2, 4 and 8, the BCD tens digit bits, and CARRY, which clocks counter H7B. This counter gives H1-8, the hundreds digit bits, and clocks H6B for thousands bits. All these bits are fed to the G6-9B multiplexers. AND gate D12B gives CNTRST at coin-up to reset score counters. The multiplexed bits M1, 2, 4 and 8 are converted to 7-segment displays by E13A, Fig. A3. These are multiplexed by D13A and F13A and fed to NOR G13A where proper bits are selected to give SCORE, which blanks GRND.

Coincidence Detection

Bomb, bandits and building coincidence is on Fig. B2. BNDVID with BB, and BOMB with BLDVID coincidences pulse HIT high for scoring. The former gives KILL for bandit and BB blanking, the latter gives BLDHIT for generation of the explosion and blanking the bomb and building. BOMB coinciding with BNDVID, GRNDVID or BULLETS also gives EXTRIG to trigger the explosion and blank appropriate simulations.

Circuits on Fig. B3 pulse CONTACT high whenever the bomber is hit by AAVID, BULLETS, BLDVID or BNDVID. CONTACT fires one-shot J12A, Fig. A2 to give FLSH high, which fires another one-shot J12A to give PLNBLNK. These signals cause the bomber to flash and reset to the right edge.

Audio Simulation

Required sounds are generated by the sound simulator in response to game commands. The actuating circuits are on Fig. B1.

GS=0 low removes AUDIO DISABLE. GS=1 high starts multi-enging plane sound (GM146 module). NOW and ACKEN high triggers the ACK ACK sound (GM172). BULEN high triggers MACHINE GUN (GM121). BOUT fires one-shot F8B to trigger BOMB TRIG for a falling bomb sound (GM114). BOMB CLR terminates this sound when EXPLOSION (GM144-3) is triggered by EXTRIG, FLSH or KILL going high.

Composite Video

The video, video blanking and horizontal and vertical sync signals are combined to create composite video for the monitor by circuits on Fig. B3. The CONTRAST pot allows contrast adjustment. VIDBLNK is generated on Fig. A1 by latch D9A. The CENTER pot allows MOVHS to be shifted slightly to center the display.

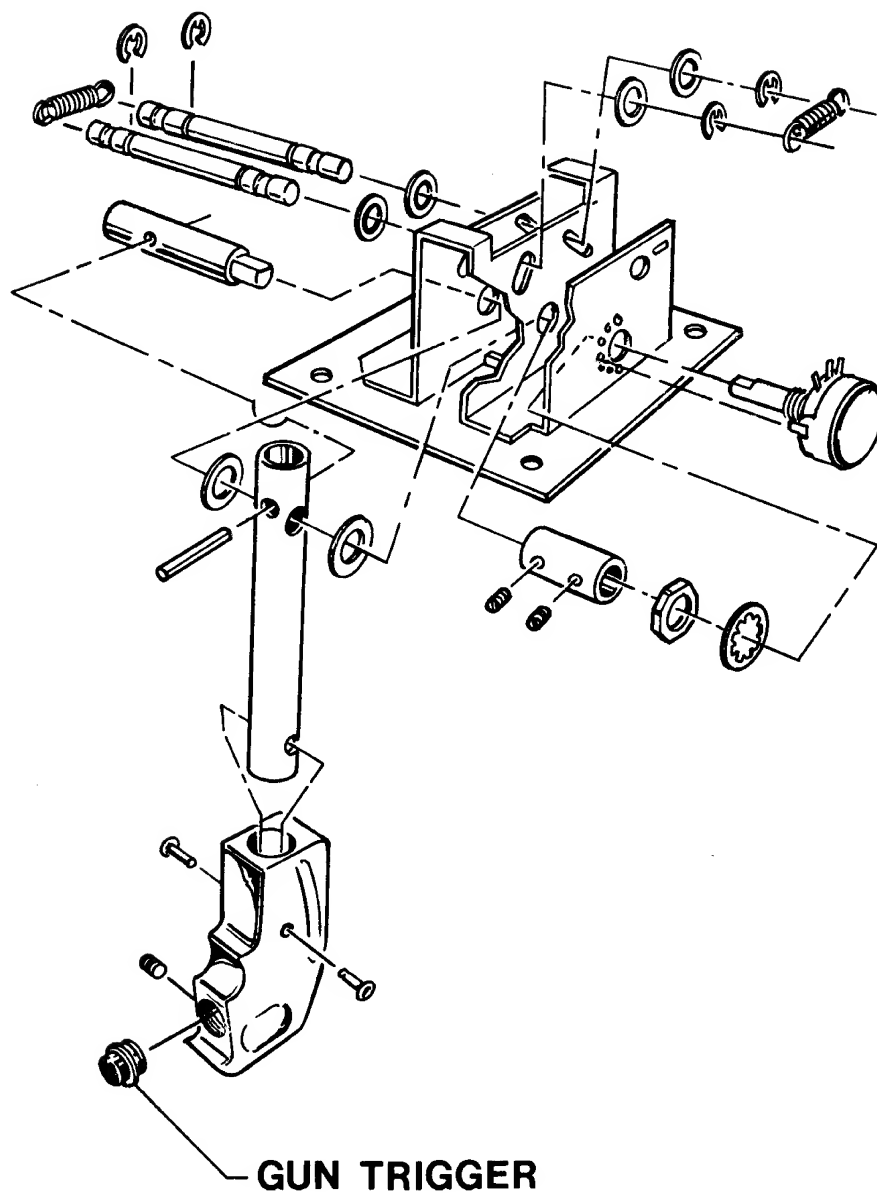
TROUBLE SHOOTING GUIDE

- 1.0 No Monitor Power - Video monitor screen is dark, front panel lamps may or may not be ON.
 - 1.1.0 Refer to monitor manual schematics. First check the fuses in the monitor. If the fuses prove good, measure the +73 VDC and +30 VDC in the monitor low voltage power supply. If these voltages are missing, measure the secondary voltages of transformer T4, check the diodes in the bridge. Especially check the Reference Amp 015 and Regulator Driver 014.
- 2.0 No Game Power - Monitor screen has brightness but no display, +5VDC on EG1060 logic boards is missing.
 - 2.1.0 Causes - Refer to EG1060 wiring diagram. Check the game fuse on the FA-1-2 board. Measure the game power transformer secondary voltage (measure about 10 VAC from each side to center tap). Check the two power diodes. You should have about 11.5 VDC at the input to the PS-5 5 volt regulator. If all checks out and +5 volts is missing, the 5 volt regulator is probably bad. However, insure that the EG1060 logic boards are not pulling down the supply due to a short. Disconnect the regulator output and throw a resistive load (1K 1/2 watt) across the regulator output to the ground. If you can now measure the +5 VDC, then the logic boards are loading down the power supply.
- 3.0 No Video - Monitor screen has brightness but no display. (We assume that the +5 VDC for the logic boards has been verified).
 - 3.1.0 Causes - Determine whether the problem is in the EG1060B logic board or the video monitor. Use an oscilloscope to measure the logic board video output on connector EC4 pin 5. If a video signal is present, the monitor is suspect. Circuit trace the monitor from the Video Input (monitor plug pin 1) to the Video Output stage (Q3).

If the video output signal is not present, then the logic board is probably not working. Refer to Figure B3. Start signal tracing at EC 4-5 and work back to I5-10. Check all inputs to I5.

If all inputs to I5 are missing, then there is a good chance the oscillator is not running or the divider chain is at fault. Check the output of E11-3.

- 4.0 Portions of Picture Detail Missing - Refer to Game Logic section.
- 5.0 No Vertical or Horizontal Sync - Picture rolls or is broken into diagonal lines.
 - 5.1.0 Causes - Misadjusted monitor vertical hold or horizontal hold controls, missing sync output from EG1060B.
- 6.0 No Credit - Game credit cannot be established when coins are deposited.
 - 6.1.0 Causes - Check the coin switch for proper operation. I12-6 (Figure B3) should pulse high when coin switch is closed.
- 7.0 No Sound - No sound when Game Start is pressed or during play.
 - 7.1.0 Causes - Insure that credit is being established since no sound is present in a no credit condition and prior to Game Start. Check the fuse in the sound system. Check the UA-10A-3 audio amplifier board for correct DC voltages.
- 8.0 Picture Dark or Very Bright -
 - 8.1.0 Causes - If the picture is very dark and pulling to the right, the CONTRAST adjustment on the EG1060B logic board may be misadjusted clockwise. If the CONTRAST is misadjusted counter clockwise, the picture will be very bright. Refer to Adjustments Section (EG1060B contrast). Note: Monitor brightness and contrast misadjustments can cause a dark picture or bright, washed out picture.



**SINGLE AXIS CONTROL
STICK
FIGURE 8**

SIGNAL GLOSSARY

<u>Signal</u>	<u>Definition</u>
AAVID	Anti-aircraft video
ACKEN	Anti-aircraft enable
AOBHER	A - Object here - Building 1 horizontal position
AS	Building 1 vertical position-setting signals
ASET	
AT	
BB	
BBCLK	Bomber Bullets video
BBPOS	Bomber Bullet clock
BLD	Bomber Bullet position address
BLD1	Combination of BLD1 and BLD2
BLD2	Building 1 simulation starting position
BLDCLK	Building 2 simulation starting position
BLDVID	Building clock, sets rate of motion
BLDHIT	Building video
BLDOUT	Coincidence signal from BOMB and BLDVID
BLD1CLR	Determines when to select Building height
BLD2CLR	Resets latches after each line of building video simulation
BLOC	Bomb Location (from bomber address)
BND1	Bandit 1, 2 simulation starting position
BND2	
BNDVID	Bandit video
BOBHER	B - Object here - Building 2 horizontal position
BOMB	Bomb video
BOUT	Bomb out, release time for bomb
B1ON	Blanks Buildings at contact
B2ON	
B1HIT	Building and bomb coincidence indicators
B2HIT	
BS	Building 2 vertical position-setting signals
BSET	
BT	
BULLEN	
BULLETS	Bandit bullet enable
BULLOC	Bandit bullets video
CHADA	Bandit bullet address
CHANADA	Change Building PROM address
CLRA	Change bomber PROM address
CLR1	Clears bomber latch after horizontal line
CLR2	Clears building latch after horizontal line
CLRHORZ	Clears bandit latch after horizontal line
COMPVID	Composite video
CONTACT	Bomber coincidence signal
CNTCLK	Control clock, master game clock
DWN	Bandit dive enable signals
2DWN	
2OEN	Score enable signals
4OEN	
8OEN	
EXEN	Explosion enable signal

<u>Signal</u>	<u>Definition</u>
EXPLOSION	Explosion video
EXTRIG	Explosion trigger
FLSH	Bomber flash
GNDVID	Ground video
GRND	Ground location
GRNDCLK	Starting point for ground
GS=1	Game start true signal
GAMOV	Game over
1H-256H	Horizontal division signals
HBH	Horizontal bomb position
HIT	Building coincidence with bomb
HPLNPOS	Horizontal bomber position
HPOS	Ack-ack horizontal position
HSYNC	Horizontal sync
INLEV	Vertical bomber position reference
KILL	Coincidence between bandit and bomber bullets
LSW	Left score window (time)
MOVHS	Movable horizontal sync for monitor
M1-8	Multiplexed BCD score bits
NOW	Random time signal for ack-ack and bandit bullet generation
PLN	Bomber position signal
PLNLD	Plane load - preset address of bomber
PLNBLNK	Plane blank - blanking of bomber at coincidence
PLNVID	Bomber video
PWRUP	Power up disable at turn-on and from static charge
RSW	Right score window (score)
SCORCNTEN	Score latch reset
SCORE	7-segment bits from score digits
SCORMUXA	Score bit multiplex signal
SNCH	Bomb address update signal
STOP	Stops bomber motion at left screen edge
UP	Bandit climb enable signals
2UP	
VB	Bomber vertical position
VBH	Vertical bomb position
VB1CLR	Clear building latch after horizontal line
VB2CLR	
VLDI	Preload bandit vertical position
VIDBLNK	Video blanking
VIDVS	Video vertical sync
VPOS	Ack-ack vertical position
VPTA	Building vertical starting point
VS/2 - VS/8	Vertical sync ÷ 2, Vertical sync ÷ 8
VSLT1	Vertical building latches
VSLT2	
VSYNC	Vertical sync
XYZ	Random signal to set building height
ZCLK	Zero clock - at time = 00.

LOGIC BOARD CONNECTOR SIGNALS

Refer to Figures 6 and 7 for connector identification.

EG1060A

Connector EC3

<u>Pin</u>	<u>Signal</u>
1	Gun Trig N.C.
2	Gun Trig N.O.
3	Static Antenna
4	+5V
5	
6	
7	
8	Ground
9	
10	
11	
12	

Connector EC5

<u>Pin</u>	<u>Signal</u>
1	VIDBLNK
2	BNDVID
3	PLNVID
4	BULEN
5	BLDHIT
6	BT
7	AT
8	BS
9	AS
10	1H
11	<u>VSYNC</u>
12	BSET
13	GS=1
14	<u>ASET</u>
15	<u>PLNLD</u>
16	<u>CLRHRZ</u>
17	VB
18	HPLNPOS
19	VS/8
20	VS/2
21	VS/4
22	<u>80EN</u>
23	<u>HSYNC</u>
24	40EN
25	CLRA

A	<u>VB2CLR</u>
B	<u>VB1CLR</u>
C	M1
D	M8
E	M2
F	M4

Connector EC5 (cont'd)

<u>Pin</u>	<u>Signal</u>
H	<u>BLD1CLR</u>
J	PWRUP
K	BND2
L	<u>SCORE</u>
M	<u>SCORMUXA</u>
N	BND1
P	HPOS
R	BLD2CLR
S	FLSH
T	NOW
U	CNTCLK
V	256H
W	PLN
X	PLNBLNK
Y	CONTACT
Z	MOVHS
a	<u>128H</u>
b	<u>8H</u>
c	HBH

Connector EC7

<u>Pin</u>	<u>Signal</u>
1	<u>BLD1</u>
2	<u>BLD2</u>
3	<u>BOUT</u>
4	BOMB
5	GNDVID
6	RSW
7	VBH
8	INLEV
9	VPOS
10	BULLETS
11	<u>SNCH</u>
12	<u>VIDVS</u>
13	BBPOS
14	BULLOC
15	BB

EG1060B

Connector EC2

<u>Pin</u>	<u>Signal</u>
1	Audioground
2	Ground
3	
4	
5	+5V
6	
7	

Connector EC2 (cont'd)

<u>Pin</u>	<u>Signal</u>
8	Audio Disable
9	Machine gun
10	Explosion trigger
11	+20V
12	40 lamp
13	20 lamp
14	Ack-ack
15	Bomb trigger
16	Bomb clear
17	Plane trigger
18	80 lamp

Connector EC4

<u>Pin</u>	<u>Signal</u>
1	Bomb Switch N.O.
2	Bomb Switch N.C.
3}	Ground
4}	
5	COMPVID
6}	+5V
7}	
8	Control arm pot
9	Coin Switch N.O.
10	Coin Switch N.C.
11	Game Start N.C.
12	Game Start N.O.

Connector EC6

<u>Pin</u>	<u>Signal</u>
1	CLRA
2	40EN
3	HSYNC
4	80EN
5	VS/4
6	VS/2
7	VS/8
8	HPLNPOS
9	VB
10	CLRHRZ
11	PLNLD
12	ASET
13	GS=1
14	BSET
15	VSYNC
16	1H
17	AS
18	BS

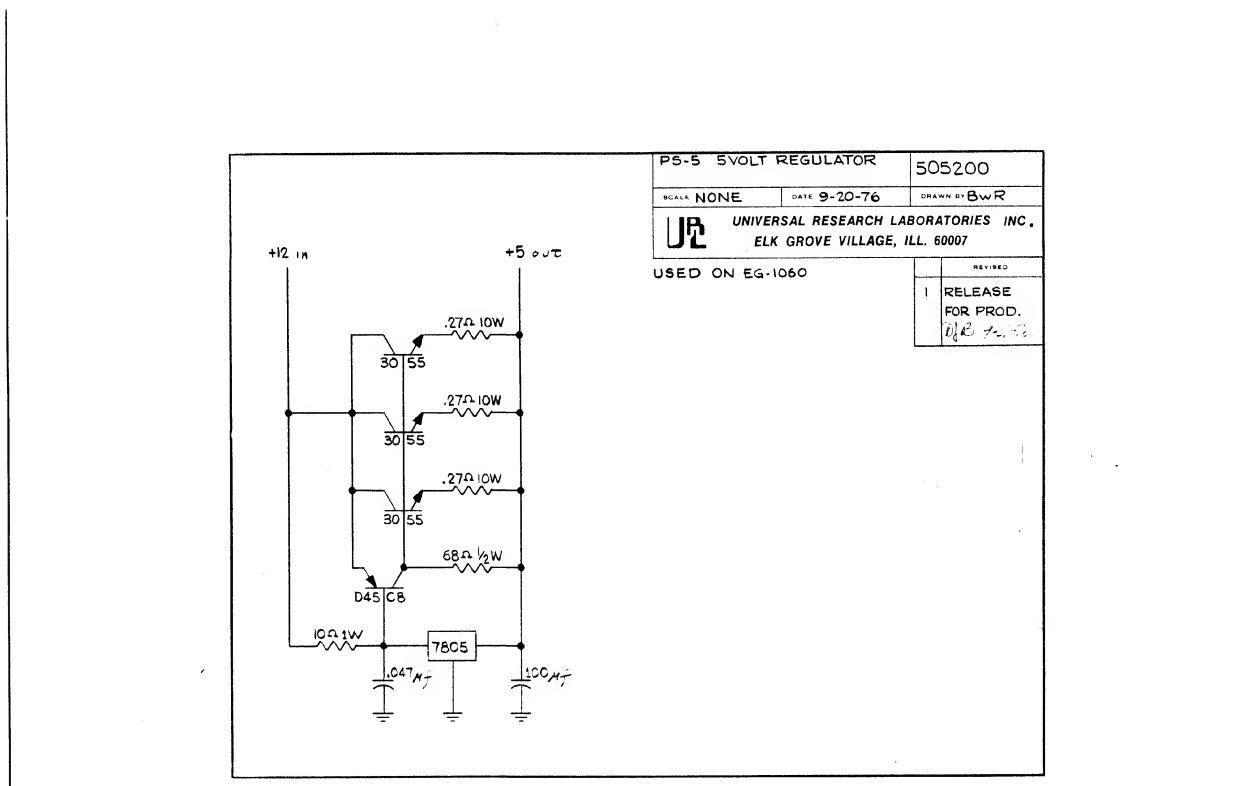
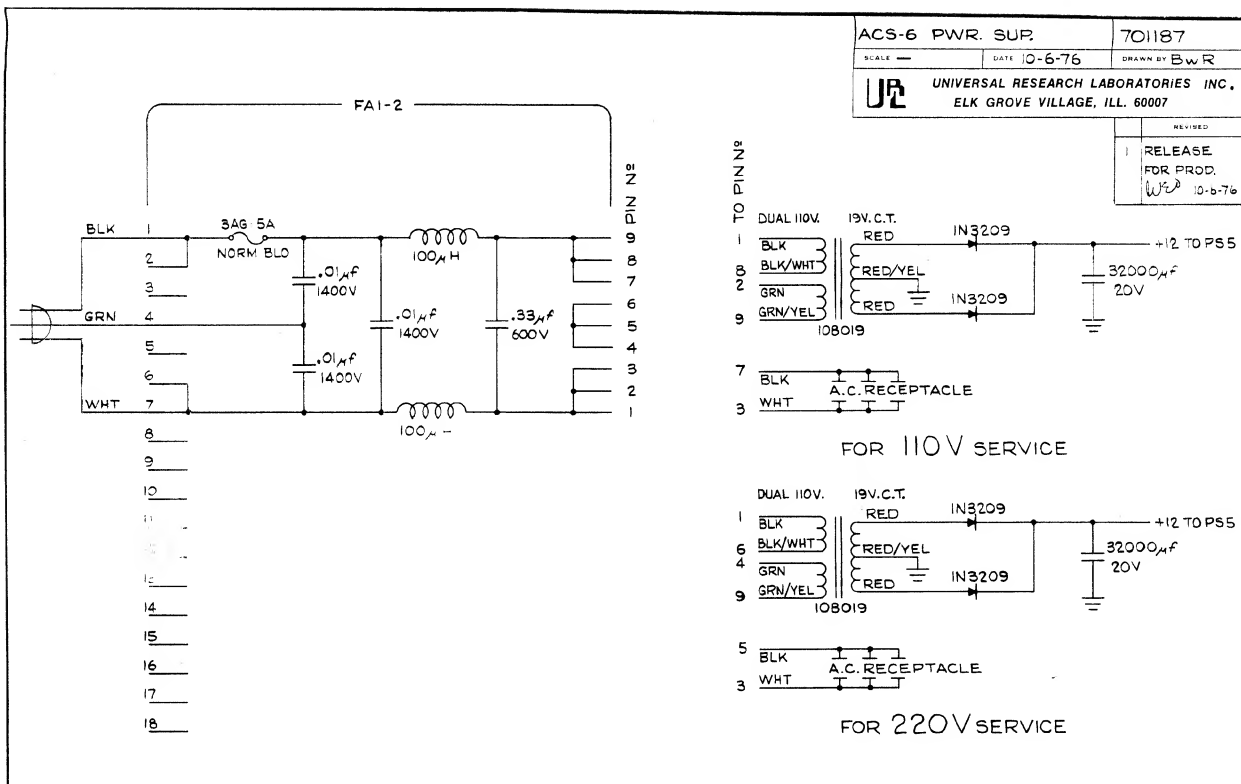
Connector EC6 (cont'd)

<u>Pin</u>	<u>Signal</u>
19	AT
20	BT
21	BLDHIT
22	BULEN
23	PLNVID
24	BNDVID
25	VIDBLNK
A	HBH
B	8H
C	128H
D	MOVHS
E	CONTACT
F	PLNBLNK
H	PLN
J	256H
K	CONTCLK
L	NOW
M	FLSH
N	BLD2CLR
P	HPOS
R	BND1
S	SCORMUXA
T	SCORE
U	BND2
V	PWRUP
W	BLD1CLR
X	M4
Y	M2
Z	M8
a	M1
b	VB1CLR
c	VB2CLR

PARTS LIST

	<u>Part Number</u>	<u>Item</u>
1.	701187	ACS-6 power supply
1.1	901144	Mounting block
1.2	108019	Power transformer, 120V Pri., 19VCT, 10A Sec.
1.3	102091	32,000 uf 20V capacitor
1.4	105050	Diode, 1N3209
1.5	116012	Heatsink
1.6	114012	Fuse block (size 3AG)
1.7	114015	Fuse, 3AG - 10A SB 32V
1.8	701120	FA-1-2 filter board (see below)
1.9	111041	Edge connector, 9 pin
1.10	111059	Receptacle, 6 pin
2.	701188	PS-5 regulator
2.1	701190	P.C. board assembly
2.2	111058	Plug, 6 pin
2.3	116018	Heat sink
2.4	118267	Mounting bracket
2.5	105020	2N3055 transistor
2.6	105045	Transistor socket
3.	701191	EG1060A logic board assembly
4.	701192	EG1060B logic board assembly
5.	701120	FA-1-2 filter board
5.1	114019	Fuse, 3AG-5A Norm-B10
6.	701195	Sound simulator
6.1	501010	Chassis assembly
6.2	501015	Interconnect (Mother) board
6.3	111010	P.C. board connector
6.4	114006	Fuse, 3AG - 1/4A Slo-B10
6.5	501345	GM 144-3 module (explosion)
6.6	501170	GM 114 module (bomb drop)
6.7	501205	GM 121 module (machine gun)
6.8	501390	GM 146 module (multi-engine plane)
6.9	501890	GM 172 module (shotgun)
6.10	501555	UA-10A-3 amplifier
6.11	108003	Power transformer
7.	901113	Monitor, Motorola 23"
8.		Coin System
8.1	901128	Double coin mechanism
8.2	701205	Coin counter assembly
8.3	901076	Coin box
8.4	901077	Coin box lid
8.5	901078	Coin box retainer

	<u>Part Number</u>	<u>Item</u>
9.	701186	Control panel assembly
9.1	119076	Push button assembly
9.2	701199	Sing axis control stick assembly
9.3	701206	Control arm adjust board assembly
10.	115022	Speaker, 8 ohm
11.		Lamp Systems
11.1	701208	120V lamp assembly
11.2	113020	120V lamp, GE 7C7/W "nite lite" or equiv.
11.3	701202	Score lamp assembly
11.4	113011	Score lamp, #47 bulb
12.		Cable Assemblies
12.1	701185	Main interconnect harness
12.2	701196	Control panel interconnect
12.3	701197	Control panel harness
12.4	701198	Monitor interconnect harness
12.5	701200	Board-to-board, 50 pin
12.6	701201	Board-to-board, 15 pin
12.7	701203	Gun trigger cable
13.	901145	Cabinet, with 2 side panels
13.1	117016	Locks, keyed alike
13.2	119033	Trim molding, brown plastic
13.3	504056	120V line cord
13.4	118277	P.C. mount pivot bracket
13.5	118278	P.C. board mounting bracket
13.6	119077	Display window
13.7	119078	Speaker grill
13.8	118272	Face trim, top edge



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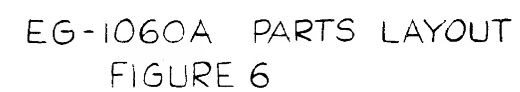
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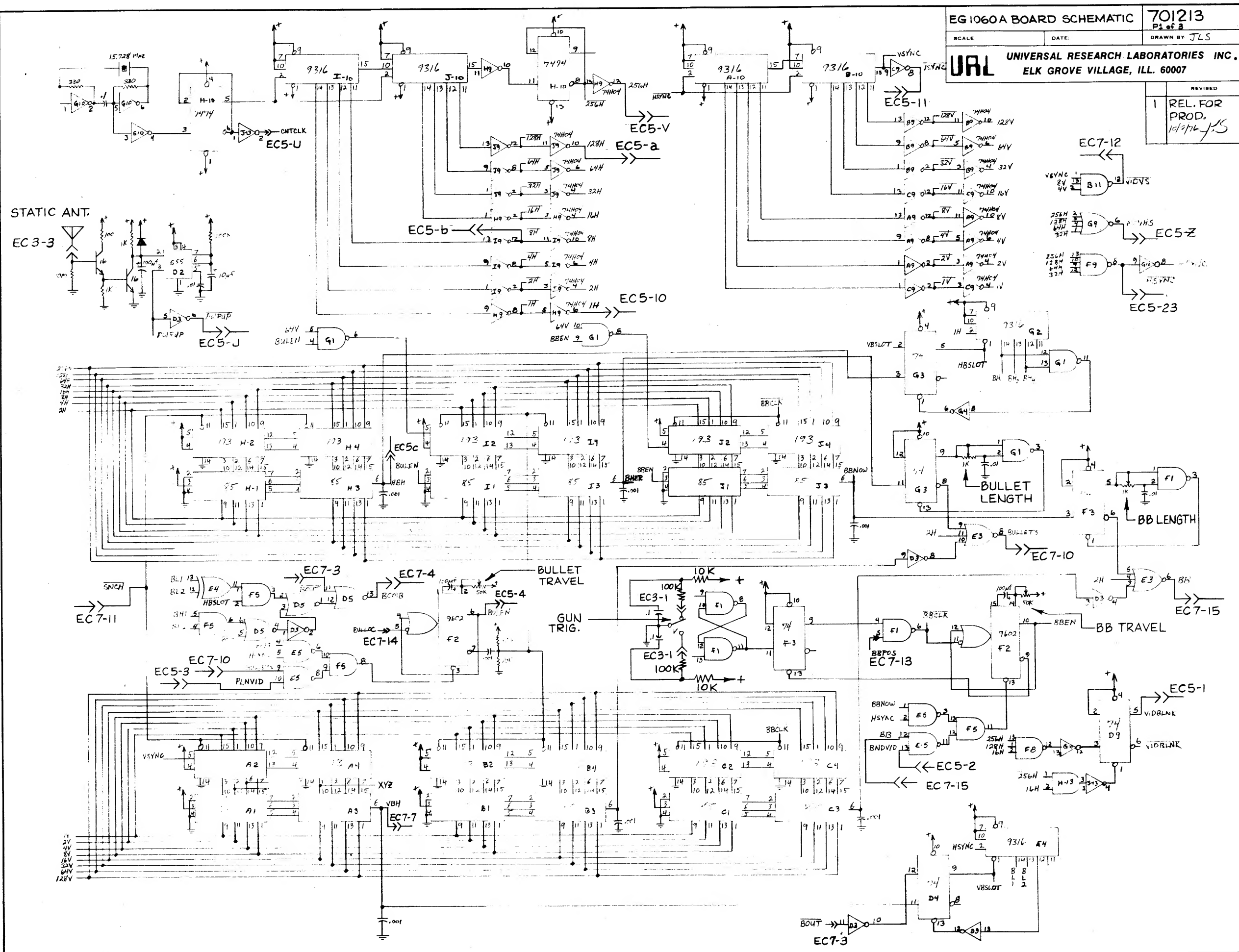
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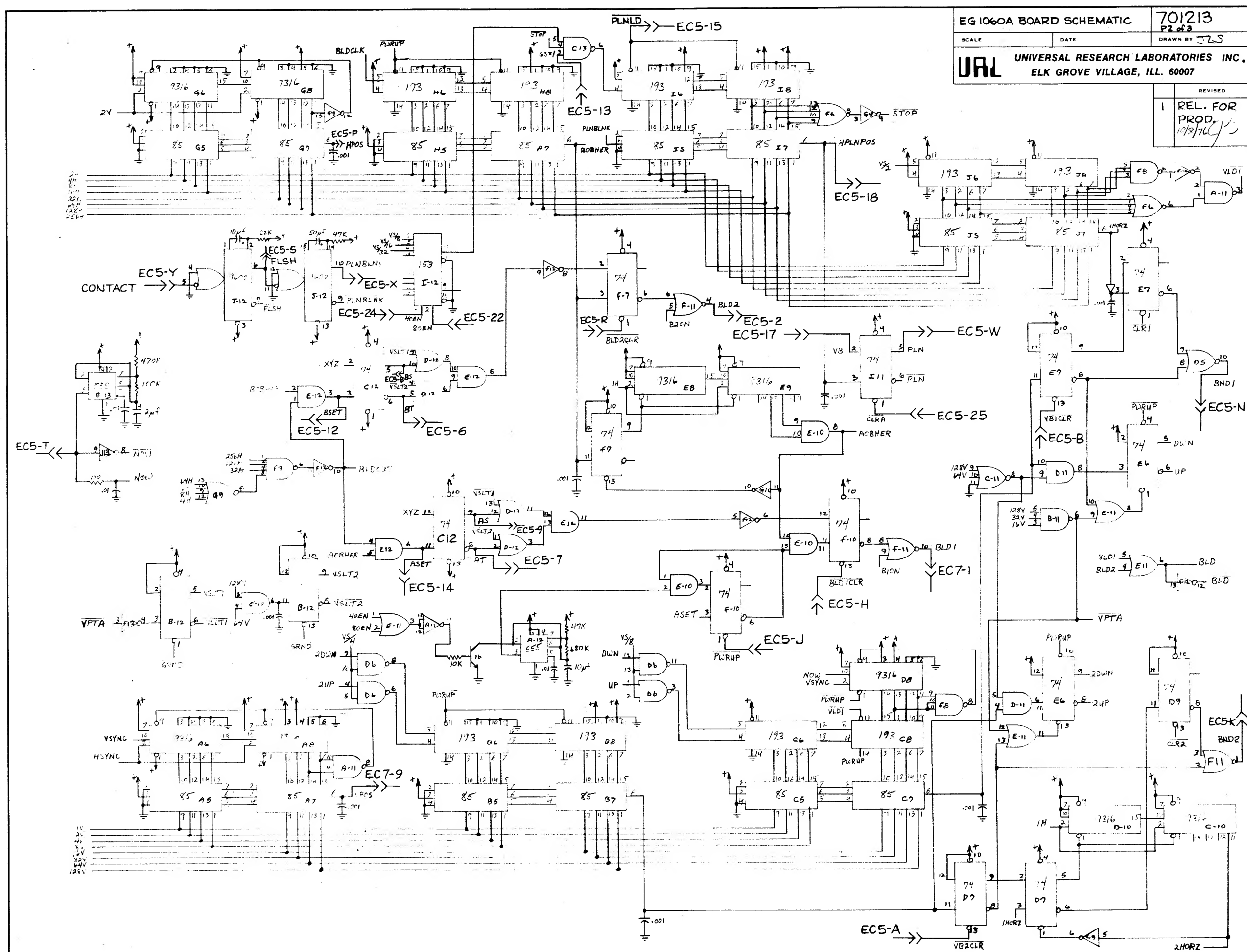
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ALL RESISTORS $\frac{1}{4}$ WATT 5%
ALL CAPACITORS: VALUES IN μ f





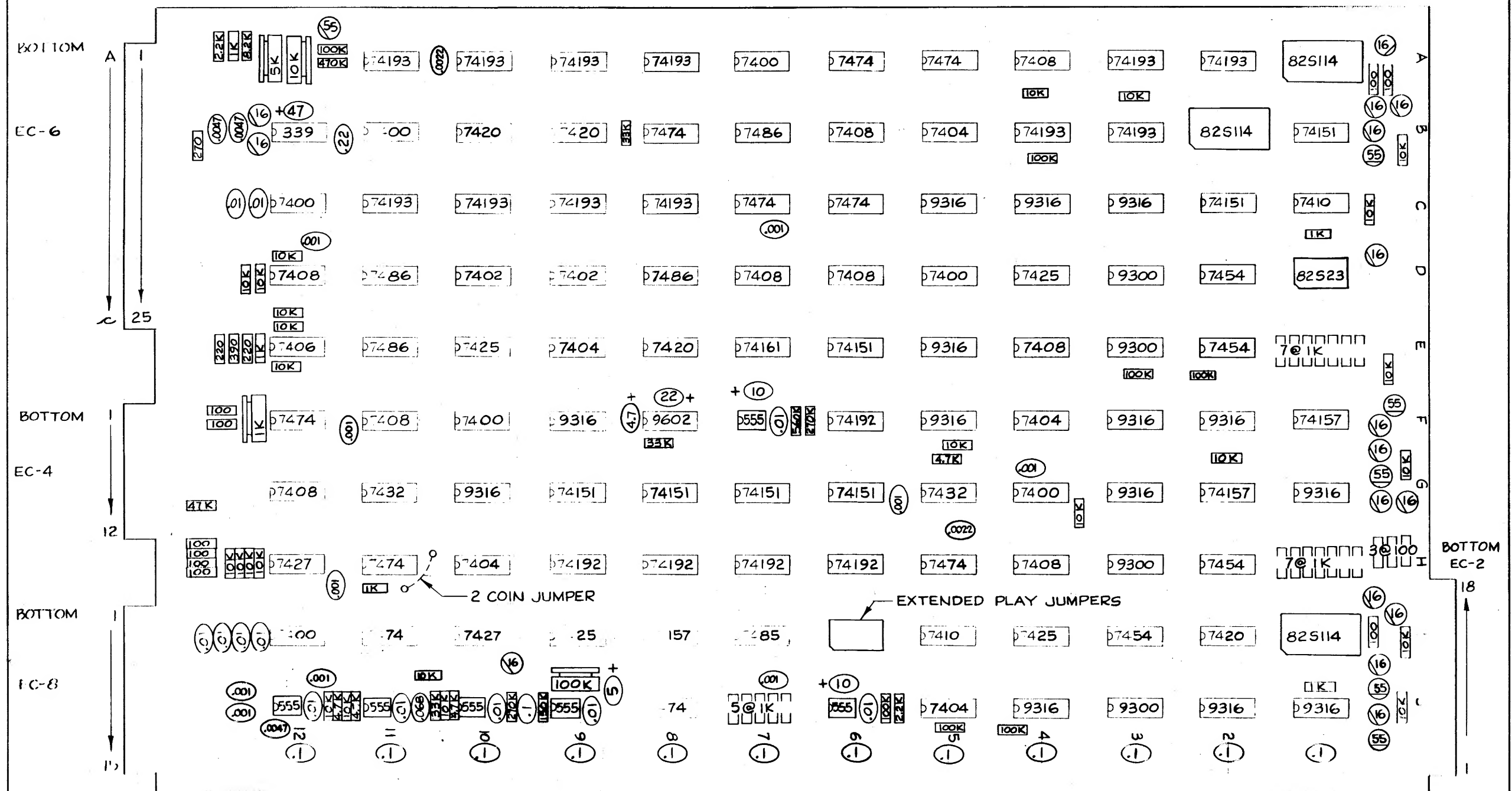


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1 REL. FOR PROD.
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NOTE
ALL RESISTORS 1/4 WATT 5%
ALL CAPACITORS: VALUES IN μ f

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EG-106 B PARTS LAYOUT
FIGURE 7

